Production of hyperons at FAIR energies

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One of the main aims of studying relativistic heavy-ion collisions is to investigate the characteristics of nuclear matter under extreme conditions of temperature and energy density. Under high temperature and/or baryon density, nuclear matter is expected to undergo a transition to a state of free quarks and gluons, known as quark-gluon plasma (QGP)[1]. The determination of yields of strange particles is one of the key parameters to study the properties of the matter created in high energy heavy-ion collisions. The relative enhancement of strange and multi-strange baryons as well as their ratios in central heavy ion collisions in comparison to those for proton induced interactions have also been suggested as a possible signature for the formation of QGP [2]. In the present work, A Multi-Phase Transport (AMPT) model [3] is employed to study production of strange particles in cental Au+Au collisions at FAIR energies (i.e. E_{Lab} = 5 to 40 AGeV). In order to see whether the hyperon production is sensitive to the degrees-of-freedom in the collision volume, both the string melting (partonic matter) and the default mode (hadronic matter) of the AMPT model have been used for calculating the particle yields.

The results of the calculations are shown as excitation functions of Λ^0 and $\bar{\Lambda}^0$ hyperons, Ξ^- and $\bar{\Xi}^+$ hyperons, and Ω^- and $\bar{\Omega}^+$ hyperons in the upper, center, and lower panel of Fig. 1, respectively. The yields have been calculated in the FAIR energy range for both modes of AMPT, i.e., string melting (partonic) and default (hadronic). In the case of $\bar{\Lambda}^0$ hyperons, the yield for hadronic production is one order of magnitude higher than the yield for partonic production at top SIS100 energies (11 A GeV), an effect which is clearly measurable. A similar effect, although smaller in magnitude, is found for $\bar{\Xi}^+$ hyperons. In contrast, the yields of Ξ^- and Ω^- hyperons for partonic production are well above the yield for hadronic production in the beam SIS100 energy range. The yield of $\bar{\Omega}^+$ hyperons seems not to be sensitive to the production mechanism. However, this result should be checked by a calculation with much better statistics. In conclusion, according to the AMPD code the yields of hyperons and anti-hyperons produced in central Au+Au collisions at FAIR energies exhibit a measurable sensitivity to the degrees-of-freedom in the fireball.

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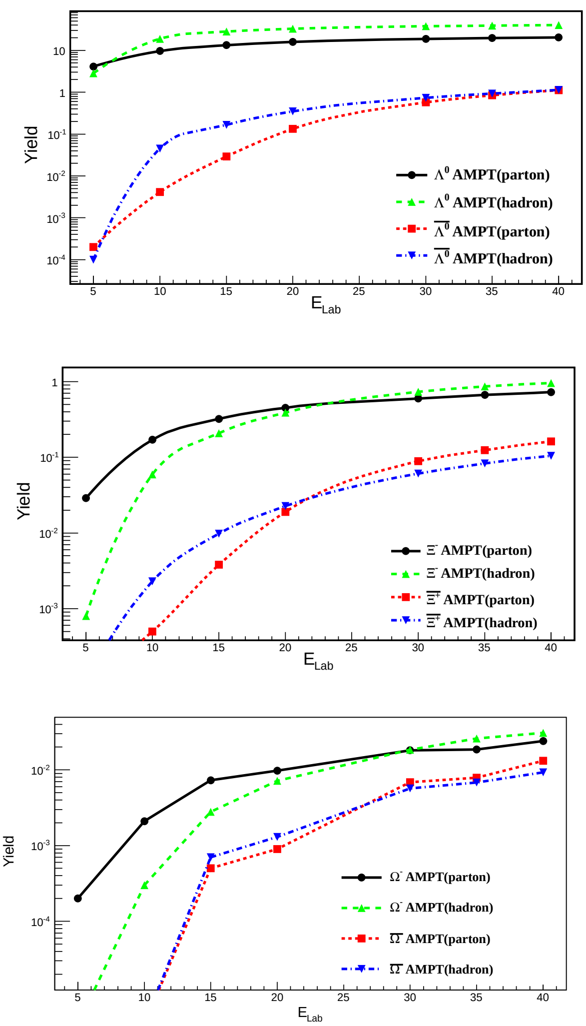

Figure 1: Yield of hyperons in central Au+Au collisions as function of beam energy calculated with the AMPT code with string melting (partonic) and without (hadronic). Upper panel: Λ^0 and $\bar{\Lambda}^0$ hyperons. Center panel: Ξ^- and $\bar{\Xi}^+$ hyperons. Lower panel: Ω^- and $\bar{\Omega}^+$ hyperons.

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